Southwest FISHERIES SCIENCE CENTER

HONOLULU LA JOLLA MONTEREY TIBURON

REPORT OF ACTIVITIES July-August 1992

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ANTARCTIC ECOSYSTEM RESEARCH GROUP

La Jolla, California

WG-Krill Meets

The Scientific Committee (SC) of the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) has established a permanent working group on krill (WG-Krill) that meets each year to discuss pertinent krill management issues. The group subsequently prepares a report for the use of the SC and ultimately for the CCAMLR Commission. Specialists who participate in the working group are nominated by members of CCAMLR. The fourth meeting of WG-Krill was held in Punta Arenas, Chile, from July 27 to August 3, 1992. Attending for the United States were Rennie Holt and Roger Hewitt of the Southwest Fisheries Science Center (SWFSC) and John Bengtson of the National Marine Mammal Laboratory.

The primary objectives of the meeting were to consider (1) investigations of the movement of krill (also known as flux) within CCAMLR Statistical Area 48 (this area covers the Atlantic sector of the Convention area) and other statistical areas; (2) estimation of total effective krill biomass in Statistical Area 48 and other areas; (3) refinement of calculations of potential yield and precautionary catch limits for krill, including evaluation of population models and demographic parameters used in such calculations; and (4) further estimation of precautionary catch limits for krill in specific statistical areas and subareas.

In addition, the SC directed the WG-Krill to address the following topics: (1) problems of by-catch of young fish in the krill fishery and possible escapement losses of krill not retained during trawling; (2) review of additional information on krill demographic parameters; (3) continued development of operational definitions of Article II of the Convention; (4) continued defining of regions of potential overlap between fisheries and foraging predators to facilitate future calculation of precautionary catch limits for krill; and (5) costs nations are likely to incur if they collect length frequency and haul-by-haul data for krill.

Before the WG-Krill could address specific objectives and topics, it had to ascertain how many tons of krill were caught during the 1991/92 fishing season. Fishing nations are required by CCAMLR to report total tons of krill caught during each fishing season. In addition, a new conservation measure, Measure 32/X, requires reports of monthly krill catches. Six members of CCAMLR; Russia, Poland, Chile, Japan, Korea, and Bulgaria; operate commercial fisheries for krill in the Convention area. For the 1991/92 season, only Russia, Poland, and Chile reported their krill catches and Russia and Poland were the only nations adhering to the requirements of Measure 32/X. By the time of the working group's meeting, Japan had not reported its 1991/92 catch; however, the Japanese estimated it to be similar to the previous year. The WG-Krill therefore concluded that at least 227,000 tons of krill were caught during the 1991/92 fishing season.

The possible relevance of krill movement with respect to the estimation of potential yield has been of concern to the WG-Krill for the last few years. Two disparate hypotheses exist in regard to krill flux: one model proposes that krill reside in closed, distinct populations within different areas of the south Atlantic (one population in the Antarctic Peninsula area, one near the South Orkney Islands, and one near South Georgia Island) while the other model suggests that krill move along an oceanic "conveyer belt" through these three areas. Current information does not exclude either of these possibilities although the general feeling of the group was that a mixed model would be most appropriate. This issue is of concern to fishing nations because adoption of the "conveyer belt" model would likely produce higher yield estimates and consequently higher catch limits.

Another task of the WG-Krill is to calculate estimates of krill biomass. Several papers concerning acoustic estimation techniques were discussed, and it was agreed that acceptable methodologies exist and should be used to estimate krill biomass. Roger Hewitt and David Demer (SWFSC) tabled a paper describing the design, analyses, and results of acoustic surveys for krill conducted in the vicinity of Elephant Island. The paper was cited as a model approach for integrating predator (penguins and seals) and prey observations. During discussions on biomass estimates, the group emphasized the importance of calibrating acoustic survey systems. Demer and Hewitt also contributed a paper outlining the theory and procedures used for calibrating an echo integration acoustic system with a standard sphere.

Acoustic data collected throughout the Atlantic sector of the Southern Ocean during the First International Biological Investigations of Marine Ant-

arctic Systems and Stocks (BIOMASS) Experiment (FIBEX) were reanalyzed using new krill target strength values to provide refined estimates of krill biomass. FIBEX was conducted in 1981 as a joint field exercise involving 12 ships from several countries, under the sponsorship of the BIOMASS. The refined estimates of krill biomass provide the basis for a population model used to determine precautionary catch limits on krill. There was considerable controversy over the inclusion of data from the German research vessel *Walther Herwig*. Krill densities estimated from these data were several times higher than those estimated from data collected by other vessels in the same areas. However, large areas of potential krill habitat were surveyed only by *Walther Herwig*, and the exclusion of these data was problematic. Ultimately, krill biomass estimates from the FIBEX data were generated with and without *Walther Herwig* data and used as inputs into the krill population model.

At the 1991 WG-Krill meeting, precautionary catch limits for krill were estimated using a model that discounted yield to allow for uncertainty in the model's parameters. During this year's meeting, yield estimates were not discounted. Rather, probability distributions for natural mortality and recruitment were used to account for uncertainty in the model's parameters. Using the modifications, new precautionary catch limits were estimated: limits ranged from 690,000 to 2,140,000 tons, depending on whether or not *Walther Herwig* data was included. The Japanese tabled a paper which questioned the accuracy of these estimates. Therefore, the working group asked the Secretariat of CCAMLR to perform an independent check on the calculations and did not recommend that current krill catch limits be modified.

Currently, the precautionary catch limit for krill in Statistical Area 48 is 1.5 million tons, but when the catch exceeds 620,000 tons, catch limits must be applied to individual subareas or local areas. George Watters of the SWFSC contributed a paper providing a number of options for the allocation of catch limits to subareas; this paper formed the basis for the working group's discussions on this issue. The group considered seven methods of allocation: (1) by biomass with and without *Walther Herwig* data; (2) by historical catch; (3) by dividing the catch equally among subareas; (4) by linear extent of the shelf break; (5) by predator demand; and (6) by local biomass adjusted for movement of krill. The working group recognized that some of these allocation schemes are easy to apply, but they do not explicitly consider relationships between predators and prey. Other alternatives are biologically explicit but suffer from a lack of data. The working group eventually recommended that a variation of the first allocation scheme would be the best long-term strategy for allocating future krill catches (J. Rosenberg, [619] 546-5600).

COASTAL FISHERIES RESOURCES DIVISION

La Jolla, California

UV Damage Measured in Larval Anchovy

The damage caused by excess ultraviolet (UV) radiation is well known to anyone who has suffered from a sunburn. The damage caused by present levels of UV radiation and the problems associated with increases in UV dose due to decreases in the earth's protective ozone layer are poorly understood for fishes inhabiting the upper layers of the ocean. Adult fishes with scales and pigments are protected from UV, but the eggs and larval stages of many fishes are transparent and are subject to increased mortality and decreased growth due to the effects of UV. Previous studies carried out by the Coastal Fisheries Resources Division (CFRD) have shown a clear relationship between UV dose and mortality for larval anchovy. This work is being continued in a new study as part of the NOAA Climate Change Program. This new study, Biological Effects of Ultraviolet Radiation on Natural Mortality (BURNM), is a collaborative effort between Physiologist Russ Vetter and Division Chief John Hunter at the Southwest Fisheries Science Center (SWFSC) and Raymond Smith at the University of California, Santa Barbara.

The objectives of the study are to monitor at the molecular level the amounts of damage caused by UV-B radiation to the DNA of larval anchovy. DNA absorbs light energy specifically in the UV region and hence is subject to chemical rearrangements due to the input of this excess energy. Exposure of DNA to UV light causes a thymine base, which should form a complementary base pair with an opposing adenine on the DNA ladder, to fuse with a neighboring thymine to form a thymine dimer (or compound). This fusion essentially makes a "spot weld" on the DNA, inhibiting expression of the gene containing the damaged DNA. Russ Vetter; together with two new employees, Geneticist

Aaron Kurtzman and Biological Technician Sydney Leff; has begun using a monoclonal antibody assay procedure that specifically detects the thymine dimer as a way of measuring DNA damage in larval anchovy.

Anchovy are induced to spawn via hormone treatment, and the eggs are hatched. Newly hatched larvae are distributed into test beakers and placed in a room with a UV dose similar to natural conditions. Control conditions and three different light levels are achieved by neutral density filters. The success of the project rests on the ability to detect very small amounts of damage in very small amounts of DNA. The average wet weight of a 4-day larva is 1 mg and the average DNA content is 9 µg. Only a small portion of the DNA will have damage (about 10^{-12} damage sites per dalton of DNA). Although the scientists believed it would take the whole first year of study to determine whether they would be able to measure DNA damage in a single egg or larva, they are happy to report that they already can after less than eight months.

Figure 1 shows the results of a preliminary experiment to detect DNA damage in individual 3-day-old anchovy larvae exposed to different levels of UV-B. There is a clear dose-effect relationship. The times of exposure were the same in each case.

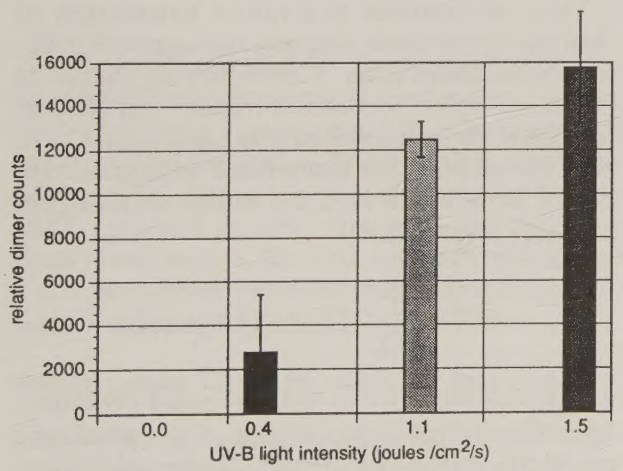

Figure 1. DNA damage in larval anchovy, *Engraulis mordax*, exposed to three levels of UV-B light. DNA was extracted, immobilized on nylon filters, and probed with a monoclonal antibody to the thymine dimer. The assay measures the intensity of a secondary antibody reaction linked to a chemiluminescence detection system. The heights of the bars are the means ±1 standard deviation for 4 to 5 individuals.

Larvae sampled the following morning had repaired the DNA damage (data not shown). In summary, it appears that the scientists have developed an assay that will allow them to follow DNA damage and repair in natural populations of larvae. They regard DNA damage as just one aspect of UV damage but one that can be measured quantitatively. This spring and summer they will put the assay to the test by collecting anchovy larvae from different depths in the water column and measuring the amounts of damage carried by individual fishes. Simultaneous to the net collections, they will make optical measurements of UV penetration in natural seawater with its associated particles, plant pigments, and other UV-absorbing compounds. In the end, they hope to generate a realistic assessment of the potential risks of increasing UV for larval fishes. (R. Vetter, [619] 546-7125).

Cost-Benefit Analysis Proposal Submitted

In September 1991, the North Pacific Fishery Council submitted an allocation proposal to the Department of Commerce for approval. The proposal recommended allocating specific shares of the total allowable catches (TAC) for pollock and Pacific cod in the Bering Sea and Aleutian Islands area and in the Gulf of Alaska to the inshore and offshore sectors of the Alaska groundfish industry. The proposed allocation was controversial due to the increased value of pollock and cod resources to U.S. fishermen and because of the dramatic changes in the patterns of operation in the fishery in recent years. It was particularly challenged on grounds of economic efficiency (its impact on net national benefits derived from the utilization of these resources).

A National Marine Fisheries Service (NMFS) Special Studies Team was formed to investigate the economic implications of the proposed pollock and cod allocations. Members of the Team included Industry Economists Sam Herrick and Dale Squires, Southwest Fisheries Science Center (SWFSC); Mort Miller, NMFS Headquarters; and John Walden, Northeast Fisheries Science Center; together with Economists Ivar Strand and Doug Lipton, University of Maryland. The team conducted a cost-benefit analysis to estimate the net national benefits of assigning specified shares of the pollock and Pacific cod TACs to the inshore and offshore sectors of the Alaska groundfish industry. The analysis broke new ground because it was the first formal cost-benefit analysis to be used in the management of an important U.S. fishery.

Background

Access to pollock and cod resources in the Bering Sea and Aleutian Islands area and in the Gulf of Alaska represents an economic opportunity of considerable value. In 1990, pollock and cod landings from the exclusive economic zone (EEZ) off Alaska were worth an estimated $313 million in exvessel revenue and accounted for 75 percent of the value of all Alaska groundfish landings. (Exvessel revenue is revenue received directly by the fishermen from the sale of fish to the processors.) Recent price increases in the world market for surimi, a major product processed from pollock, and in strong roe and domestic fillet markets, signify a vast profit potential for pollock harvesting and processing operations in the EEZ.

The inshore sector of the Alaska groundfish industry includes shore-based processing plants and harvesting vessels that deliver raw product to these plants. Offshore, the industry consists of large factory trawlers that catch and process fish; motherships, which are floating processing plants; and catcher vessels that deliver catches to motherships and factory trawlers.

The Council's allocation proposal was in response to a claim by the inshore sector that its access to the TAC was in danger of being "pre-empted" by the large and growing offshore sector. The issue surfaced in 1989 when, after a relatively short pollock season in the Bering Sea, several large factory trawlers moved into the Gulf of Alaska and took a portion of the pollock TAC that the shore-based sector was planning to use. Incentives for future incursions of offshore fleets into areas closer to shore are significant. The offshore fleet has more capacity than needed to take the entire TAC and, given the strong market environment, could be expected to expand operations near shore. The inshore sector sees this as a threat to potential profits, incomes, and jobs.

The proposed allocation regime would probably result in a significant decline in production by the offshore sector and an increased production by the shore-based sector. Offshore operators accounted for over 80 percent of the pollock taken in the Bering Sea and Aleutian Islands fishery in 1990, but under the proposed rules, their share would be capped at 55 percent in 1994 and 1995. At the same time, the inshore sector would increase its share of Bering Sea and Aleutian Islands pollock from 20 percent to 45 percent. In the Gulf of Alaska, the proposed allocation grants the inshore sector exclusive rights to pollock along with 90 percent of the cod allowance. During 1990, offshore operators took 15 percent of the pollock TAC in the Gulf of Alaska and 23 percent of the cod TAC.

Under the Magnuson Fishery Conservation and Management Act, management actions must conform to national standards that require inclusion of an important criterion: the extent to which net benefits are affected. Similarly, Executive Order 12291 stipulates that regulations should aim at maximizing net benefits for society and that "rules be developed with a cost-benefit approach when possible."

In a cost-benefit analysis, the benefit of a management action is the economic value of additional goods and services made possible by the action, as measured by changes in producer and consumer surplus. The change in producer surplus is an estimate of benefits to producers as measured by the difference between additional producer revenue and changes in operating costs and new economic investment. Consumer surplus is an estimate of the benefits to consumers as measured by the difference between what consumers are willing to pay for a product or service and what they actually pay. The sum of changes in producer and consumer gains minus management and enforcement costs is the net benefit to the nation.

Approach and Scope of the Analysis

Data limitations precluded estimation of changes in consumer surplus, management costs, and enforcement costs. Consequently, change in producer surplus was used to measure net national benefits from the proposed allocation regime. For both the offshore and shore-based sectors, the following formula was used to compute the change in producer surplus (ΔPS):

$$\Delta PS = \sum_{i=1}^{n} (p_i \Delta q_i - c_i \Delta q_i)$$

where p_i is the price of the processed product i, Δq_i is the change in production of the processed product i, c_i is the average variable cost of production (for instance; fuel, labor, and raw materials) for the processed product i, and n is the number of products.

Results

Results of the cost-benefit analysis show large reductions in economic benefits for offshore operations and gains for the inshore sector. The inshore gains, however, would not be great enough to offset

the offshore losses. The proposed action would therefore result in significant losses in net benefits to society.

According to the analysis, producer surplus (or net earnings) is reduced by $619 million in the offshore sector and increased by only $438 million in the shore-based sector over the life of the allocation program (Table 1). The difference represents a $181 million loss to society (Table 1). A risk analysis, to take into account uncertainty in the value of key variables, indicated that there is almost no chance that net benefits from the proposed allocation would be positive. In Monte Carlo simulations conducted for the risk analysis, losses ranged from $15 million up to $350 million.

Table 1. Net benefits (losses) in millions of dollars to the shore-based and offshore sectors of the Alaska groundfish fishery over the operational years of the proposed allocation regime. Annual net benefits are discounted at a five percent real rate of interest to estimate the net present value (NPV) of benefits over the life of the allocation.

SECTOR	YEAR				
	1992	1993	1994	1995	NPV (5%)
Inshore	$65	$124	$156	$156	$438
Offshore	($83)	($178)	($224)	($224)	($619)
Net	($18)	($54)	($68)	($68)	($181)

The cost-benefit analysis demonstrates that, under current technology and market conditions, the offshore sector is able to convert the resource into a higher-valued product at lower relative costs despite the fact that its raw fish discards are higher and its product recovery rates are lower than the shore-based sectors. In effect, a shift in production to the shore-based sector would erode the value of pollock stocks. (S. Herrick, [619] 546-7111)

Domoic Acid Toxin in Anchovy Studied

Domoic acid is a human neurotoxin that is derived from certain diatom species of the genus *Nitzschia* (microscopic planktonic plants which have built up high levels of this compound). This acid has recently been discovered in anchovy. Apparently, the anchovy concentrates the toxin from diatoms in its food supply and passes it on to other species which feed on it. Unlike the more familiar dinoflagellate toxin which causes the closure of the mussel season each year during the summer, domoic acid is not well enough known to determine geographic or seasonal limits. Many shellfish fisheries have been closed on the Pacific coast because of findings of domoic acid in the shellfish, and there are monitoring programs for the incidence of this toxin.

Because of the recent discovery of domoic acid in anchovy, Coastal Fisheries Resources Division (CFRD) scientists have compiled a list of associates of the northern anchovy, based on CalCOFI files and analyses of Geoffrey H. Moser, leader of the Ecology and Systematics of Fishes group in the CFRD. The list indicates that the chief fish associates of anchovy which have commercial value are sardine, rockfish, hake, tuna, and mackerel. Anchovy and sardine feed on similar food organisms, plant and animal. Anchovy and sardine interact with other fish associates mainly as prey.

Scientists have been aware of the domoic acid problem on the Pacific coast for only about a year. On the Atlantic coast, researchers were made aware of the problem when they learned of the deaths of three people and the neuropathologic crippling of a few dozen individuals five years ago. It appears that the species of diatom involved on the Pacific coast is different from, but related to, the species on the Atlantic coast. (P. Smith, [619] 546-7169)

MARINE MAMMAL DIVISION

La Jolla, California

Research Vessel Survey to Assess Status of Central Stock of Common Dolphins Begins

On July 28, 1992, two NOAA research vessels, *David Starr Jordan* and *McArthur*, departed from San Diego, California, to conduct a 3-month survey of dolphins in the eastern tropical Pacific Ocean (ETP). The overall objective of this project is to survey the area inhabited by the central stock of common dolphin in order to make an estimate of its absolute abundance for assessing the impact of the dolphin mortality caused by the United States and the international yellowfin tuna purse-seine fishing fleets in the ETP.

In 1984, the United States Congress delegated the responsibility of studying ETP dolphins to the National Marine Fisheries Service (NMFS). These studies were subsequently initiated by the Center in 1986 after extensive planning and program re-

view. Five surveys have been completed to date (1986-1990). Though the power of the test statistic was low, no trends in abundance have been detected.

Research vessel data from current surveys will be used to estimate minimum abundance for the purpose of setting absolute quotas on mortality for individual stocks as proposed in a resolution agreed to by the members and cooperating nations of the Inter-American Tropical Tuna Commission (IATTC). To date, reliable estimates of abundance have been made for most of the stocks of spotted, spinner, and striped dolphin; however, abundance estimates for common dolphins are not considered very reliable because of the limited sightings. The 1992 and 1993 surveys have been designed to obtain these estimates.

During this year's Population of *Delphinus* Stocks (PODS) survey, Southwest Fisheries Science Center (SWFSC) scientists representing all programs within the Marine Mammal Division are responsible for collecting information on the density, size, and species composition of marine mammal schools encountered in the ETP. The PODS survey is primarily designed to collect data required to make minimum abundance estimates of cetacean stocks encountered along predetermined tracklines (Fig. 1), in particular, of the central common dolphin, *Delphinus delphis*. Physical, biological, and oceanographic data regarding the habitat of marine mammals inhabiting the ETP are also being collected in order to better understand marine mammal distributions. Aerial photographs of dolphin and tuna schools are being taken from a helicopter aboard *Jordan* and are being used to calibrate observer estimates as well as for species identification. On an opportunistic basis, aerial photographs of other cetaceans offer valuable information on distribution and age structure of these species. Photographic identification of dolphins and whales are conducted aboard both vessels. And finally, because sea turtles and sea birds interact with tuna purse-seine vessels, a number of projects have been designed to collect data on their distribution, movements, association with dolphin schools, and general ecology in the ETP.

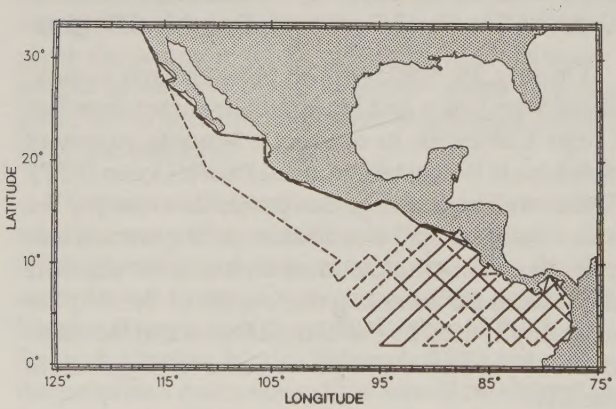

Figure 1. Dashed lines are the tracklines followed by *Jordan* and solid lines are for *McArthur* on the 1992 Population of *Delphinus* Stocks (PODS) survey. The tracklines cover the range inhabited by the central stock of common dolphins.

The first leg of the survey has been completed as scheduled for both vessels, which collected data while crossing Mexican waters on the way to the study area. Of special interest was a school of approximately 52 Baird's beaked whales, *Berardius bairdii*. This species is generally considered rare and is not usually found in such large associations. In total, approximately 237 cetacean schools were sighted aboard *McArthur* and 417 cetacean schools were sighted from *Jordan* during Leg 1. The helicopter flew approximately 66 hours, photographing schools of marine mammals as well as tunas. On August 26 both vessels entered port at Puerto Quetzal, Guatemala.

The second leg of the survey began on August 31 and is expected to reach port in Panama by September 29. The third leg will be initiated on October 4. *Jordan* will follow predetermined transects northward, returning to San Diego by November 2. *McArthur* will continue to survey the study area and return to Panama where preparations will be made to initiate the first "Dolphin-Safe" research vessel cruise. This cruise will be a cooperative venture involving the Inter-American Tropical Tuna Commission, the academic community, and the fishing industry. (J. Sisson, [619] 546-7064).

COASTAL MARINE MAMMAL PROGRAM

On July 21-22, 1992, the Coastal Marine Mammal Program completed a two-aircraft survey of bottlenose dolphins, *Tursiops truncatus*, along the California coast from the U.S./Mexico border north to Pt. Conception. On July 21, two Aspen Partenavia fixed-wing planes surveyed the same survey area, flying just one hour (approximately 100 nautical miles) apart. The use of two aircraft will aid in determining if separate surveys flown over a short time period yield similar data on the number of

dolphins present in the survey area. On July 22, the survey was completed using only one aircraft.

Survey conditions on the first day (July 21) were good, with clear skies and an average Beaufort sea state of 3 (gentle breeze). The coastal waters were very muddy during much of the survey, probably due to high surf conditions generated by recent hurricanes offshore. On this day, the leading aircraft (recorded as survey A) detected 6 sightings of bottlenose dolphins, with a total of 52 animals. School sizes for survey A ranged from 7 to 12 animals, with a mean of 8.5 animals. The trailing aircraft (recorded as survey B) detected 5 sightings of bottlenose dolphins, for a total of 64 animals. School sizes for survey B ranged from 2 to 26 animals with a mean of 12.8 animals. Survey conditions on the second day (survey C) were good, with clear skies, and an average Beaufort sea state of 2.5 (light to gentle breeze). Water turbidity near the coast was high once again. Survey C detected 6 sightings of bottlenose dolphins, for a total of 38 animals. School sizes for survey C ranged from 1 to 22 animals, with a mean of 6.3 animals. Figure 2 shows the sighting locations of bottlenose dolphins encountered during the three overflights.

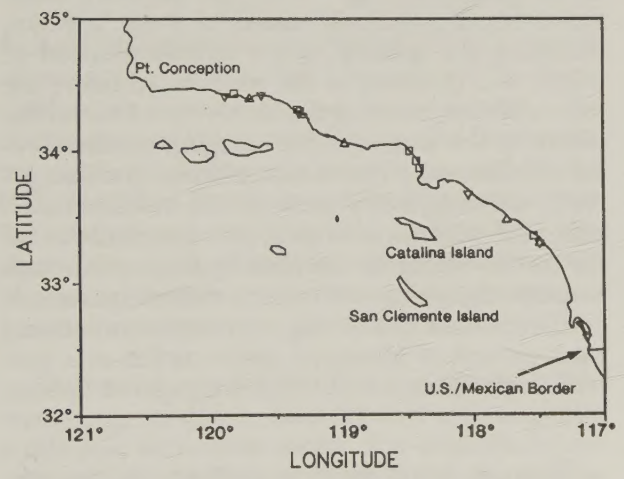

Figure 2. Bottlenose dolphin surveys completed along the California coast from the U.S./Mexican border north to Pt. Conception on July 21-22, 1992. ❑= Survey A, Δ = Survey B, ∇ = Survey C, superimposed triangles = one survey from Survey B and one from Survey C.

To date, this survey has resulted in the fewest number of bottlenose dolphins sighted on a survey. Surveys are flown every other month throughout the year. Previous surveys have resulted in as many as 215 dolphin sightings during one flight (October 1991) and in sightings of school sizes as large as 85 animals (December 1991). The unusually high turbidity of the coastal waters during this survey made it difficult to make school size counts and probably resulted in many animals being missed by observers. During survey A, a series of three sightings (19 animals) was made between Santa Monica and Pt. Vincente, California. The animals were not seen during survey B approximately one hour later. It is possible that the animals may have moved offshore during this period, thus making them unavailable (availability bias) to survey B observers. It was noted during survey C that a group of bottlenose dolphins which was sighted by the observers was obviously moving offshore. How often these movements occur and how far offshore the coastal animals range is not fully known.

The unusually low number of bottlenose dolphins sighted, compared with previous surveys, may also indicate some net movement of dolphins north along the California coast in response to warm water El Niño conditions. According to R. S. Wells et al., 1990, bottlenose dolphins extended their range north to Monterey Bay during the 1982/83 El Niño event. And T. Norris et al., 1990, photo-identified at least 18 animals in Monterey Bay between October 1990 and October 1991. Future surveys may be flown north of Pt. Conception to determine the presence and abundance of bottlenose dolphins in this region during such El Niño episodes. (J. Carretta, [619] 546-7181).

HONOLULU LABORATORY

Honolulu, Hawaii

PROTECTED SPECIES INVESTIGATION

Juvenile Monk Seals Collected at French Frigate Shoals for Rehabilitation and Release at Midway Islands

The French Frigate Shoals (FFS) population of Hawaiian monk seals is continuing the decline which began in 1990 (Fig. 1). The number of births is approximately the same as last year, well below the annual number of births in the late 1980s. The 1992 mean beach count (to date) is 161 (range 146-170), down from the 1991 mean count of 191 (range 159-238).

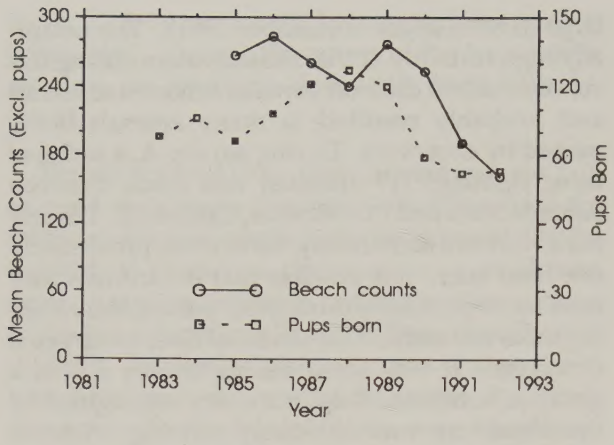

Figure 1. Mean annual beach counts and number of pups born at French Frigate Shoals. Note that data points for 1992 are based on five atoll counts.

The decline appears to be due to loss of subadults and juveniles. These size classes are at their lowest level since annual population monitoring by this program began at FFS in 1984. Known hauling patterns suggest a total loss in the population on the order of 75 seals during the last year.

Furthermore, a high proportion of the surviving juveniles and subadults are severely emaciated. Eighty-one percent of the yearlings sighted in 1992 were considered to be either emaciated or thin. Similarly, 43 percent and 61 percent of 2 year olds and 3 year olds, respectively, were classified as emaciated or thin; and a sample of juvenile seals weighed in 1992 and compared to 1991 samples confirmed the poorer condition and the correspondingly reduced probability of survival of these young seals. Combined with recruitment failures of seabirds and spiny lobsters, these data suggest the most likely cause is lack of available food resources.

The results of a disease investigation at FFS in April suggested that infectious disease was not contributing to the decline. Following this finding, seven thin-to-emaciated seals (aged 1-3 years) were collected at FFS and transported to Oahu, arriving on May 7. They were taken to an isolated beach enclosure on Oahu where attempts were made to feed them with herring, conduct further disease screening, and initiate disease treatments as necessary. The two males in the group died of pneumonia soon after arrival, but the five females (one with successfully treated pneumonia) quickly recovered. All were transported to Midway Islands and released in August as healthy seals. They will be monitored closely to compare their survival rates with those of seals which were in the same condition originally but which are remaining at FFS.

Collections and disease screening of emaciated seals will be continued at FFS in September with the goal of relocating up to 10 seals directly to Midway for rehabilitation and release. The animals taken to Midway will be held in a beach enclosure for continued fattening and then released as soon as they have gained weight and are deemed to be in good health, which is expected to require 1-2 months. (W. Gilmartin, [808] 943-1239)

Satellite Transmitters Deployed to Track Migratory Pathways of Hawaiian Green Turtles

During early August, small transmitters linked to the Argos satellite system were attached to three adult green turtles, *Chelonia mydas*, nesting at French Frigate Shoals (FFS) in the Northwestern Hawaiian Islands. Tagging with metal flipper tags at FFS in past years has demonstrated that turtles periodically undertake reproductive migrations to this remote location from algal foraging pastures scattered throughout the main Hawaiian Islands, up to 800 miles away. However, there are many unanswered questions related to these voyages, including the oceanic routes followed, speed of travel, and duration of the trip. In addition, the means of navigation, and whether or not the turtles return to the same specific foraging pastures, remain unknown. The fibropapilloma disease currently affecting many green turtles in Hawaii also raises the question as to what the impact may be on the turtles' ability to successfully accomplish such lengthy migrations. All of these factors are considered important to the long-term conservation and management of Hawaiian green turtles as a protected species under the U.S. Endangered Species Act.

Thus far, two of the three turtles with transmitters have departed from FFS heading on an east-southeast course, against the prevailing winds and currents, in the direction of the main Hawaiian Islands. Turtle U236, moderately afflicted with tumors, has now been at sea for 16 days and traveled about 400 nautical miles (26 nmi/day) in a highly zigzagging course. The second turtle, U260, without tumors and in apparent good health, has been at sea for 10 days heading in the same general direction but on a steady, straight course. U260 has covered about 210 nmi, averaging 21 nmi/day. Neither turtle appears to be following, nor is anywhere near, the chain of islands and shoals (i.e.,

Necker I., Nihoa I.) geologically linking FFS with the main Hawaiian Islands. Results from tracking turtle U260 will be especially valuable because it had been previously captured and flipper-tagged in Kaneohe Bay, Oahu, a known algal foraging pasture for green turtles. If this turtle returns to Kaneohe Bay, the hypothesis of site fidelity for a resident foraging pasture will be strengthened.

The third turtle, U306, was still at FFS when the last transmission was received. Additional clutches of eggs were likely being laid, as commonly occurs when green turtles migrate to their nesting beaches. U306 also has the potential to supply significant data when she embarks on her high-seas migration. This turtle was originally flipper-tagged by Honolulu Laboratory personnel in 1983 in a foraging pasture adjacent to Johnston Island, an isolated atoll about 400 nmi south of FFS. (G. Balazs, [808] 943-1240)

PELAGIC RESOURCES INVESTIGATION

Advanced Molecular Biological and Biochemical Techniques Course Completed

Leader of the Ecological Physiology Program Richard Brill spent 6 weeks during July and August attending a course at the University of Southern California's Catalina Marine Science Center. The course, entitled "Molecular Biology and Biochemistry of Marine Organisms," was sponsored by the Office of Naval Research and the National Science Foundation and was intended to introduce students to the application of the newest and advanced biochemical and molecular biological techniques to questions in the marine sciences.

The course was divided into six, approximately week-long, modules. Each module was taught by a different set of instructors. The techniques covered included the following: amino acid measurement and protein composition analysis using high pressure liquid chromatography with UV, radiochemical, and electrochemical detection; protein isolation and identification using 1-D and 2-D polyacrylamide gel electrophoresis; RNA and DNA isolation procedures; the creation of DNA probes for specific genes; nucleic acid hybridization (Southern blots) for gene identification using both autoradiography and immunological detection techniques; the use of Northern blots for specific RNA identification; epifluorescence microscopy; DNA sequence analysis; the use of polymerase chain reaction for DNA amplification; gene cloning; protein identification using Western blots; enzyme analysis of specific eye lens chaperone proteins; and construction of cDNA libraries from mRNA.

The intensive course included both lectures and ample "hands-on" laboratory work. In order to cover this broad range of material in only 6 weeks, classes and laboratories were held 6 days a week. Potential application of these techniques to Honolulu Laboratory research programs are being reviewed. (R. Brill, [808] 943-1234)

INSULAR RESOURCES INVESTIGATION

Diver-biologists Assess Abundance of Reef Fish Prey of Monk Seals at French Frigate Shoals

During July 1-17, 1992, reef fish abundance and biomass were assessed at French Frigate Shoals (FFS) in the Northwestern Hawaiian Islands under the guidance of Edward DeMartini, leader of the Insular Ecology Program. This effort was in response to the concern that juvenile and newly weaned Hawaiian monk seals at FFS were starving as a result of a reduction in the availability of their reef fish prey. The three-person survey team, headed by Frank Parrish, fishery biologist, included two University of Hawaii personnel. The diver-biologists counted and sized reef fish at select sites in the waters surrounding the atoll. Surveys were conducted at the same locations as fish surveys completed in the early 1980s by the Hawaii Cooperative Fishery Research Unit (HCFRU) of the University of Hawaii, Manoa. Comparison of the two sets of data could possibly indicate whether reductions in reef fish abundances have occurred at FFS between the summer of 1992 and the decade prior, when the monk seal population at FFS was healthy despite greater seal densities.

Five of the nine stations were located on continuous reef habitat inside and outside the atoll's barrier reef. The remaining four stations surveyed were patch reefs surrounded by sand, situated within the barrier reef. The 36 dives completed by the team produced replicate data sets using two complementary methodologies. The first method was identical to that used during the original HCFRU surveys, thus allowing direct interdecadal comparisons. The second method provided abundance estimates based on greater reef area coverage; these data should provide a better baseline for potential future surveys and temporal comparisons.

Computer-entry of the summer 1992 data is nearly complete. As of the end of August, data analysis is limited to a companion evaluation of the accuracy and precision of the divers' in situ visual estimates of fish body sizes. On the average, the three practiced divers were able to estimate the body lengths of fishes ± 9-11 percent of actual body lengths. (E. DeMartini, [808] 943-1266; F. Parrish, [808] 943-1254)

Lobster Fishery Quota Revised

Commercial lobster catches and catch-per-unit effort (CPUE) have decreased substantially since 1990 at Maro Reef, one of the two major fishing areas in the Northwestern Hawaiian Islands (NWHI). The fishery is now under seasonal closures and an annual quota. Research by Investigation Chief Jeff Polovina and University of Hawaii Oceanographer Gary Mitchum was used to set a pre-season quota estimate of 750,000 lobster for the 1992 NWHI commercial season. The quota estimate was calculated in February 1992 using commercial CPUE from the previous year, average lobster recruitment and mortality estimates, and sea level-based assumptions about spiny lobster recruitment to Maro Reef in 1992. These figures were used in a dynamic CPUE-based model to predict a commercial CPUE for the start of the 1992 lobster season. The estimated July 1992 CPUE was then used in a CPUE-based quota model, which uses CPUE as an indicator of abundance, and sets the allowable catch at a level which allows the stocks to rebound to long-term average levels while providing lobster fishers with economically viable catch rates.

A research cruise to the NWHI in June of 1992 indicated that recruitment at Maro Reef had not improved by mid-1992. The commercial NWHI lobster season opened July 1, 1992, with continued poor catches of spiny lobster at Maro Reef. The commercial catch-and-effort data from the first month of the fishery was used in the CPUE-based quota model to calculate a final seasonal quota of 438,000 lobster for 1992.

To enable lobster fishers to plan their fishing schedules, a correlation between time of year and average catch, allowing for decreases as the year progresses due to stock depletion and weather, was used with the commercial data from the first month of fishing to estimate the length of the 1992 season. Based on these data, the season was estimated at about 4 months. Updates of total catch as the season progresses will be made based upon vessel call-ins of catch data and from logbook data. (W. Haight, [808] 943-1236; J. Polovina, [808] 943-1218)

PELAGIC FISHERIES RESOURCES DIVISION

La Jolla, California

MULTISPECIES DATA COLLECTION AND EVALUATION PROGRAM

1991 North Pacific Albacore Summary Completed

Gary Rensink has co-authored with Forrest R. Miller, Inter-American Tropical Tuna Commission (IATTC), Administrative Report LJ-92-30 "Summary of the 1991 North Pacific albacore fisheries data." The report describes the results of the sampling program carried out during the 1991 North Pacific albacore season.

The 1991 U.S. North Pacific albacore fishery started in mid-May and continued through mid-October. The overall sampling coverages for catch-and-effort and length-frequency information were 62 percent and 61 percent, respectively, compared to 57 percent and 56 percent in 1990. The 200+ vessels participating in the fishery expended an estimated 3,866 days fishing (sampled days fishing/coverage rate) compared to 5,523 days fishing in 1990.

In 1991, the U.S. fleet caught albacore from 33°-53° N latitude and from 151° E longitude to the U.S. west coast (Fig. 1). Catches were highest in August, roughly 900 to 1,300 miles west of southern Oregon and about 50-150 miles south of Cape St. James (Queen Charlotte Islands). Catches from the commercial fishery reflected a new record low of 1,845 t (metric tons) for 1991 compared to 2,818 t in 1990 (Fig. 2).

The overall catch rate in 1991 of 36 fish/day was the same as in 1990 (Fig. 3). The highest nominal catch rates in 1991 occurred roughly 1,300 miles west of central Oregon in July (155 to 220 fish/day) and 1,250 miles west of central Oregon in August (205 to 260 fish/day). This area was farther offshore than where the highest catch rates were recorded in 1990 (190-225 fish/day).

Over 24,000 albacore were measured for fork length (tip of snout to fork of the tail) from the landings of vessels participating in the 1991 U.S. North Pacific fishery. The average fork length of fish measured decreased considerably from 16.4 lbs (71.0 cm) in 1990 to 12.6 lbs. (65.1 cm) in 1991 (Fig. 4). Fish ranged in size from 41 to 117 cm (Fig. 5).

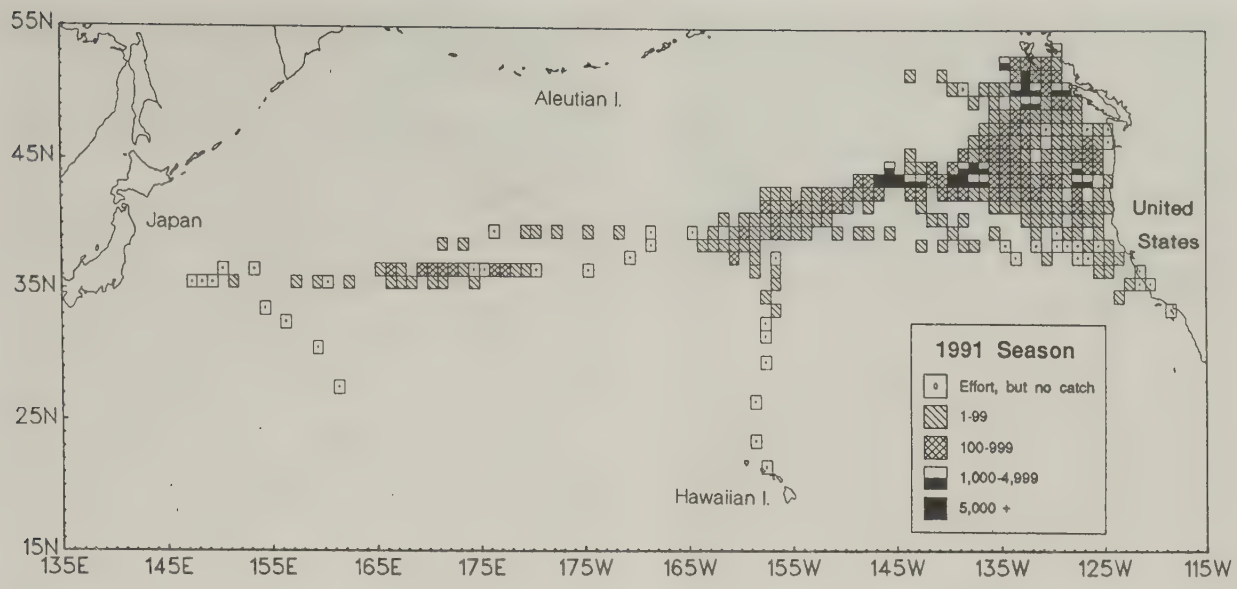

Figure 1. U.S. albacore catch (numbers of fish) by 1° quadrangles in the North Pacific Ocean, 1991 season.

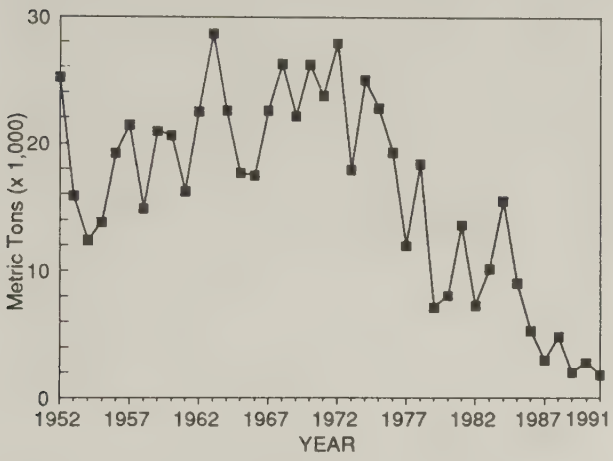

Figure 2. U.S. North Pacific commercial albacore catch by year, 1952-1991.

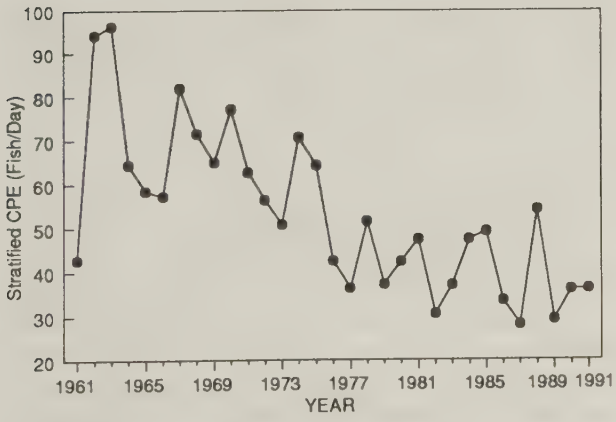

Figure 3. U.S. North Pacific albacore jigboat stratified catch per effort (fish/day) by year, 1961-1991.

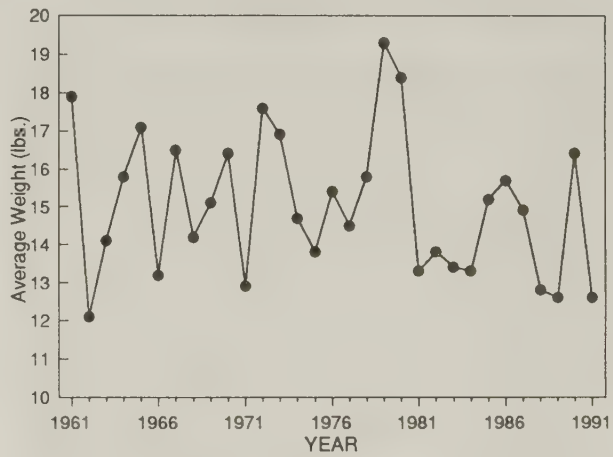

Figure 4. Average weight (lbs.) of North Pacific albacore caught by U.S. vessels by year, 1961-1991.

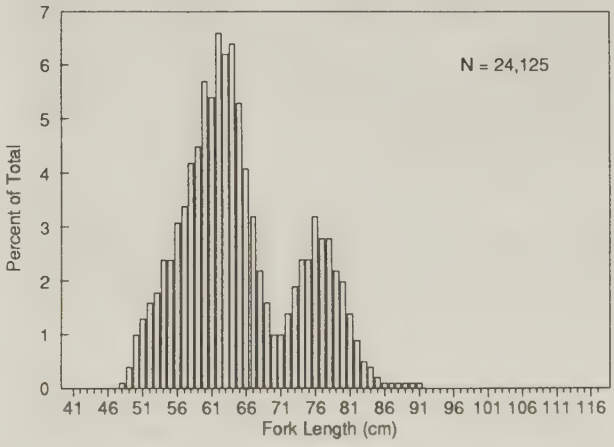

Figure 5. Length frequency histogram of fish caught by the U.S. North Pacific albacore fleet, 1991 season.

Albacore fishing activity began in July along the western edge of the sea surface temperature (SST) frontal edge formed by coastal upwelling between Cape Blanco and Monterey Bay. In August and September, fishing was concentrated in the offshore SST ridge, where isotherms bulged northward toward Vancouver Island and also in the coastal region from Vancouver Island to northern California, where strong coastal upwelling had formed numerous SST frontal edges.

National Marine Fisheries Service observers accompanied four U.S. troll vessels on four trips, starting in early July and finishing in late September 1991. A total of 12,466 albacore were examined and measured. Overall, 3.1 percent of the catch examined showed evidence of net-related damage (1.9 percent recent damage, 1.2 percent healed scars from earlier net encounters), compared to 12.4 percent for observed trips in 1990 (7.2 percent recent damage, 5.2 percent healed scars from earlier net encounters). (G. Rensink, [619] 546-7192)

STOCK ASSESSMENT AND FISHERY IMPACT ANALYSIS PROGRAM

Pro Am and Hawaiian International Billfish Tournaments Held in August

A record number of blue marlin, *Makaira nigricans mazara*, were tagged and released during the Pro Am and Hawaiian International Billfish Tournaments conducted off Kailua-Kona, Hawaii, in early August 1992. Seventy-six fishing teams from throughout the world tagged and released 128 billfish using National Marine Fisheries Service (NMFS) tags. Blue marlin accounted for 122 of the billfish. Five striped marlin, *Tetrapturus audax*, and two shortbilled spearfish, *Tetrapturus angustirostris*, were tagged. Seven additional blue marlin were tagged by anglers using Australian tags (five) and Billfish Foundation tags (two). A grand total of 135 billfish were tagged.

The estimated weights on the tag cards were totaled, indicating that over 9.7 tons of billfish had been tagged and released during the two tournaments. Blue marlin comprised 9.6 tons of the 9.7 tons tagged and released.

Three days after a blue marlin had been tagged by a Hawaiian International Billfish Tournament contestant from Tahiti, the tagged blue marlin was recovered off Keauhou Bay, a few miles south of Kailua-Kona, Hawaii. (J. Squire, Jr., [619] 546-7072)

PELAGIC ECOSYSTEM MODEL DEVELOPMENT PROGRAM

Tag Data Shows Effect of FADs on Tuna Movement

Fishery Biologist Pierre Kleiber has returned to La Jolla from a one-year posting to the South Pacific Commission (SPC) in Noumea, New Caledonia. The posting was a collaborative arrangement between NMFS and the SPC's Tuna and Billfish Assessment Programme, based on mutual interest in monitoring the status of tuna stocks in the central and western Pacific Ocean. The Tuna and Billfish Assessment Programme has been conducting tuna tagging operations throughout that region, and Kleiber's principal objective during his stay was to use a subset of the tag return data to develop a skipjack population dynamics and movement model for the Solomon Islands (Fig. 6). The ultimate use for the model is to address concerns about fishery development and fishery interaction in the region. In particular, there are questions about the effectiveness of deploying more floating aggregation devices (FADs) in the Solomon Islands to further develop a local purse-seine fleet. There are also concerns about the possible effects such development has had, and will have, on a previously established pole-and-line fleet.

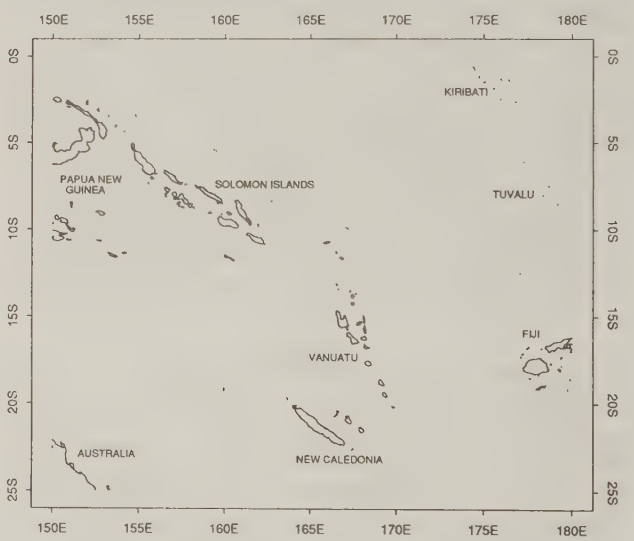

Figure 6. Map of Solomon Islands area.

Working in collaboration with SPC Fishery Scientist John Hampton, Kleiber developed a model which incorporates natural mortality and fishing mortality by purse-seine and pole-and-line fleets. In addition, it deals with skipjack movement which is affected by the presence of FADs and also by the

presence of islands. The effect of FADs on movement is implemented into the model by a two-parameter submodel which is programmed to make the assumption that FADs in a half-degree (30-nautical-mile) square diminish the tendency of skipjack to depart from that square. The effect increases with increasing numbers of FADs in a square but approaches a saturation level. The effect of islands also had to be considered. First, because the surface area of the Solomon Islands is significant in the geographic scale of the model, and second, because the island archipelago appeared to have its own attractive effect on skipjack.

Fitting the model to the tag data allowed the two FAD parameters to be estimated along with five other model parameters. Disabling the FAD effect significantly diminished the fit of the model. It therefore appears that some signal from the FADs is inherent in the tag data and that the model is sensitive to it and captures at least some of that signal. Modification of individual tuna movement behavior by FADs has been observed with sonic tracking (K. N. Holland, R.W. Brill, and R.K.C. Chang 1990), but this is the first time it has been documented with ordinary tag release and recovery data.

During his stay at SPC, Kleiber also established a computer connection between SPC and the La Jolla Laboratory using the Pacific-wide Peacesat system which makes use of National Oceanic and Atmospheric Administration's GOES 3 satellite. This linkage should be helpful in further collaboration between National Marine Fisheries Service and the Tuna and Billfish Assessment Programme, both for continued development of the above model and for other projects of mutual interest. (P. Kleiber, [619] 546-7076)

TIBURON LABORATORY

Tiburon, California

FISHERY MANAGEMENT ADVISORIES

Contaminants May Have Contributed to Decline of Pacific Sardine

While at the Southwest Fisheries Center (SWFC) in La Jolla in 1986, Michael Prager (now at Southeast Fisheries Science Center, formerly at Old Dominion University, Norfolk, Virginia) and Alec MacCall (now at the Southwest Fisheries Science Center [SWFSC] Tiburon Laboratory) conducted a National Ocean Service (NOS)-funded biostatistical study of the effects of contaminants on southern California fish stocks. While preparing the results of that work for publication in *Fishery Bulletin*, the authors discovered an error in their earlier sardine, *Sardinops sagax*, stock-and-recruitment data and recently revised their analysis of contaminant and climate effects on that stock. The new analysis suggests a strong correlation between contaminants and the decline of the sardine stock from the late 1940s to the mid 1960s.

The authors first reduced a very large data set of climate and contaminant measurements to 10 statistically independent aggregate variables by means of principle components analysis. Assuming a Ricker stock-recruitment curve, the authors then modeled sardine spawning success (log recruits-per-spawner) as a "linear combination" of selected aggregate variables, each associated with a coefficient whose value was estimated by the statistical regression procedure. The time series of annual values of those linear sums is called the "explanatory effect" of the model, and relationships to original climate and contaminant variates are indicated by the respective correlation coefficients.

Although not attempting formal hypothesis tests, the authors imposed three statistical criteria which needed to be met before they would consider that detectable contaminant effects might have occurred. The first criterion was qualitative: The correlations of the chosen model's explanatory effect with most contaminant variables (i.e., those known to be deleterious) had to be negative. The second and third criteria were quantitative: The regression coefficients of the chosen model had to be statistically significant, and the inclusion of contaminant information had to provide more explanatory power than use of climate data alone. If all three criteria were met, the authors considered that the study provided sufficient evidence to question the null hypothesis: "Any apparent effects of contaminants can be explained by random variability alone, including chance association with climate effects."

Two other pelagic fishes were also examined by this procedure, northern anchovy, *Engraulis mordax*, and Pacific mackerel, *Scomber japonicus*. Of the three species, only the sardine met all three of the criteria. This result suggests that contaminant stress, at a time of severe overfishing, contributed to the decline and collapse of the Pacific sardine stock. The authors emphasize that for a number of technical reasons, they cannot attach any level of statistical certainty to this suggestion, nor can they

identify which individual contaminant or group of contaminants is the most likely culprit. However, this research produced a model of high explanatory power (R^2=0.83) in which contaminants were strongly represented, and that makes a strong case for further research into the question. Results of this study will appear in *Fishery Bulletin*, and a more extensive report is being prepared for publication as a NOS Technical Memorandum. (A. MacCall, [415] 435-3149)

GROUNDFISH COMMUNITIES INVESTIGATION

Methods Developed to Use Otolith Microstructure to Identify Juvenile Rockfishes

Accurate identification of the larvae and early juveniles of rockfishes, *Sebastes* spp., is a vital need of the Groundfish Communities Investigation. There is, however, a problem distinguishing species at these early life history stages because existing methods of identification emphasize features of adults that are undeveloped in very young individuals. Fishery Biologists Tom Laidig of Tiburon Laboratory's Groundfish Communities Investigation and Steve Ralston of the Groundfish Analysis Investigation have completed studies which identify features of otolith microstructure that distinguish these species during their earlier life stages.

Eight rockfish species represented among specimens taken with mid-water trawl from 1983 to 1989 were analyzed for differences in otolith microstructure: *S. auriculatus*, *S. entomelas*, *S. flavidus*, *S. goodei*, *S. jordani*, *S. mystinus*, *S. paucispinis*, and *S. saxicola*.

After being removed from the fish, each sagitta was viewed under transmitted light, and two characters were measured: (1) the radius of the nucleus and (2) the width of the first increment. Mean values for each were then calculated based on data from all specimens of each species taken during all years. An ANOVA (analysis of variance), incorporating separate pairwise *t*-tests, was performed to highlight significant differences between the two characters, both among species and among years. A two-way factorial analysis was used to evaluate the differences between species, years, and the combination of species and years. A parametric discriminant analysis was then used to determine the percentage of each species that was correctly identified using the two characters alone and in combination.

Sebastes jordani had the largest average radius of nucleus (Table 1, Fig. 1). Based on this character, the other species ranked as follows: *S. goodei*, *S. auriculatus*, *S. paucispinis*, *S. flavidus*, *S. entomelas*, *S. saxicola*, and *S. mystinus*. Individually, *S. jordani*, *S. goodei*, *S. auriculatus*, and *S. mystinus* differed significantly (ANOVA, P<0.05) from all other species in radius of nucleus.

Table 1. Mean otolith nuclear radius and first increment width among rockfish *Sebastes* spp. specimens taken with mid-water trawl from 1983 to 1989 (all years combined). SD = standard deviation. N = sample size.

Species	N	Nuclear Radius (µm)	SD	First Increment (µm)	SD
S. auriculatus	56	14.07	1.48	0.82	0.20
S. entomelas	147	11.81	0.94	0.72	0.13
S. flavidus	122	12.09	0.69	0.72	0.16
S. goodei	230	15.15	0.89	0.85	0.17
S. jordani	541	16.96	0.99	0.97	0.23
S. mystinus	106	10.93	1.05	0.65	0.14
S. paucispinis	277	12.20	1.14	0.91	0.18
S. saxicola	12	11.58	0.90	0.73	0.23

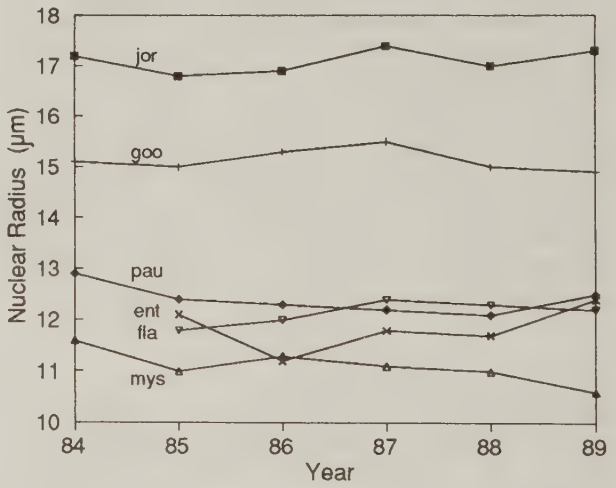

Figure 1. Annual variation in otolith nuclear radii for the six rockfish species that had multiple year observations. ent = *S. entomelas*, fla = *S. flavidus*, goo = *S. goodei*, jor = *S. jordani*, mys = *S. mystinus*, and pau = *S. paucispinis*.

Sebastes jordani also had the largest average first increment of all species studied (Table 1, Fig. 2), with others ranking as follows: *S. paucispinis*, *S. goodei*, *S. auriculatus*, *S. saxicola*, *S. flavidus*, *S. entomelas*, and *S. mystinus*. *Sebastes jordani* and *S. paucispinis* had significantly larger first-increment

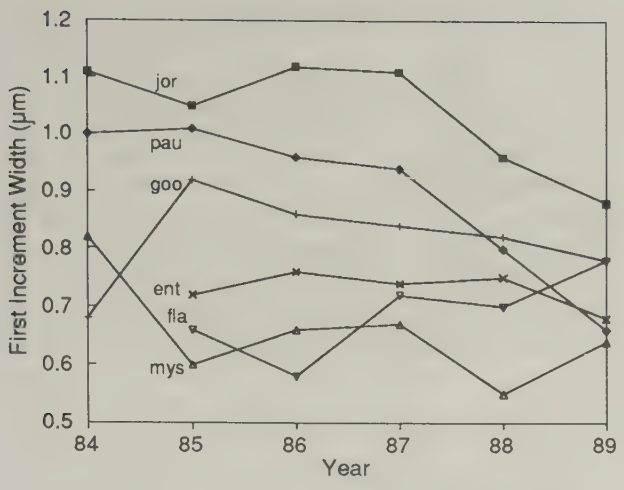

Figure 2. Annual variation in first otolith increment width for the six rockfish species that had multiple year observations. ent = *S. entomelas*, fla = *S. flavidus*, goo = *S. goodei*, jor = *S. jordani*, mys = *S. mystinus*, and pau = *S. paucispinis*.

widths (ANOVA, $P<0.05$) than all other species studied (0.97 µm and 0.91 µm, respectively). The remaining species yielded few significant interspecific differences. Differences from year to year were insignificant in radius of the nucleus (ANOVA, $P> 0.05$; Fig. 1) but significant in width of the first increment (ANOVA, $P<0.05$; Fig. 2).

Using these characters, all but *S. entomelas* and *S. saxicola* were identified correctly more often than not. *S. entomelas* was frequently misidentified as either *S. flavidus* or *S. mystinus*, whereas *S. saxicola* was often misidentified as *S. flavidus*, *S. mystinus*, or *S. paucispinis*.

These results are encouraging and suggest that otoliths can indeed be used to aid in the identification of larval and juvenile rockfish. The procedures developed can also be combined with patterns of shading observed within the nucleus and patterns of pigmentation on the body to increase biologists' ability to identify rockfish species during their early life histories. (T. Laidig and S. Ralston, [415] 435-3149)

GROUNDFISH ANALYSIS INVESTIGATION

Annual Recruitment Survey of Juvenile Rockfish Successfully Completed

A research cruise aboard the research vessel *David Starr Jordan* was recently completed by investigators at the Tiburon Laboratory. The cruise, DSJ-9206, extended from May 9 to June 19, 1992. The goal of the cruise was to determine the distribution and relative abundance of pelagic young-of-the-year juvenile rockfish, genus *Sebastes*, inhabiting the region from Cypress Point (36°30′ N) to Tomales Point (38°20′ N) and out to a distance ~80 km offshore (123°30′ W). As in years past, operations during the cruise were primarily oriented toward completing three consecutive "sweeps" of a series of 35 fixed nighttime midwater trawl stations.

Due to the prevalence of El Niño conditions in the months prior to the cruise, results from the survey contrasted with what might be considered typical. In particular, trawl catches of the juvenile rockfish were (1) quite low, (2) the fish were very small, (3) relative abundance tended to increase as the cruise progressed, and (4) there was a striking reduction in the catch of northerly distributed species, especially yellowtail rockfish, *S. flavidus*; widow rockfish, *S. entomelas*; black rockfish, *S. melanops*; and canary rockfish, *S. pinniger*. Species captured in unusually large numbers this year included the copper rockfish complex (copper rockfish, *S. caurinus*; gopher rockfish, *S. carnatus*; black-and-yellow rockfish, *S. chrysomelas*; and splitnose rockfish, *S. diploproa*) and members of the *Sebastomus* subgenus (rosy rockfish, *S. rosaceus*; swordspine rockfish, *S. ensifer*; and greenspotted rockfish, *S. chlorostictus*). All these results are consistent with patterns observed in previous El Niño years, particularly 1983 and, to a lesser extent, 1986. Dramatic reductions in fish size were particularly evident this year, with the juvenile rockfish ranging in size from ~15-35 mm standard length (SL), compared with a more typical size range of 30-70 mm SL.

A major objective of the rockfish recruitment surveys is to obtain annual indices of rockfish year-class strength. However, we have noted significant interannual differences in the size composition of the juvenile rockfish captured since the surveys began in 1983 (Fig. 3). Numerical annual abundance indices must be adjusted for these differences in size to develop meaningful statistics. The first step in this process is to evaluate the selective properties of the modified Cobb trawl used in the surveys, which has a 1/2" mesh inner-liner sewn into the cod-end. Thus, one of the secondary objectives of the cruise was to conduct a series of trawls as part of a net selectivity study.

Catches obtained with the 1/2" mesh inner-liner were compared with catches from a 1/4" mesh inner-liner to evaluate aspects of the trawl's se-

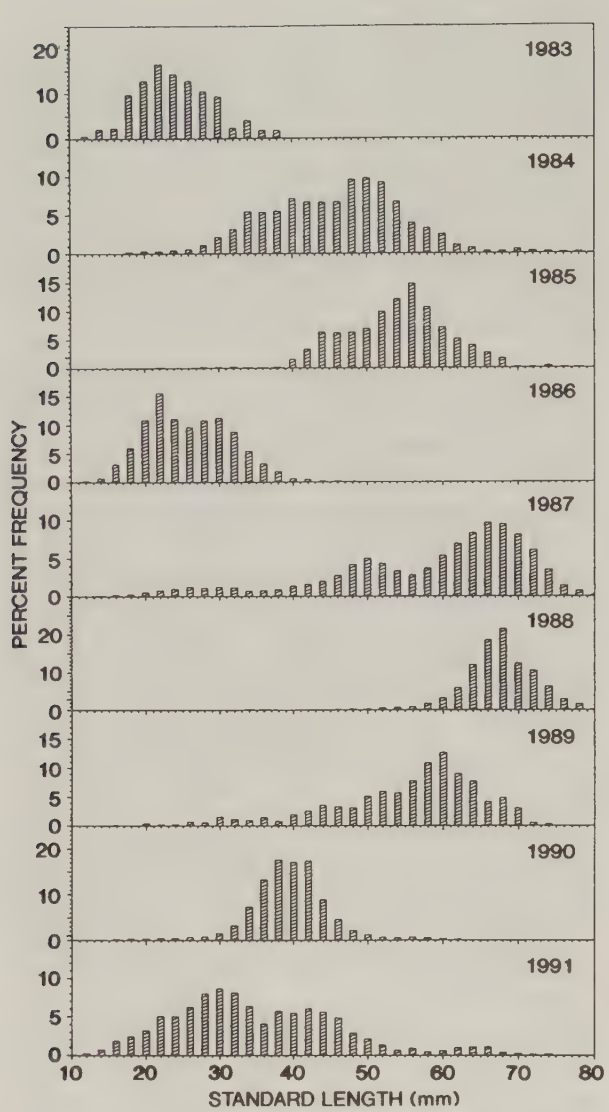

Figure 3. Length-frequency distributions of pelagic juvenile rockfish inhabiting a region from Cypress Point to Tomales Point, California, and to a distance about 80 km offshore (1983-91). Only May-June samples of the 15 most fequently caught species are shown (species combined).

lectivity. Three nights were spent trawling in areas of relatively high juvenile rockfish abundance (two nights off Cypress Point and one night off Davenport). Due to time constraints imposed in changing the inner-liners, each mesh size was fished sequentially for 3-4 trawls, after which the liners were exchanged. An initial examination of the data suggests that juvenile shortbelly rockfish, *Sebastes jordani*, ≥20 mm SL, are sampled effectively with the 1/2" mesh (Fig. 4). Furthermore, there was some evidence that relatively fewer large fish were caught with the 1/4" mesh liner. This may have been due to some clogging of the finer mesh with

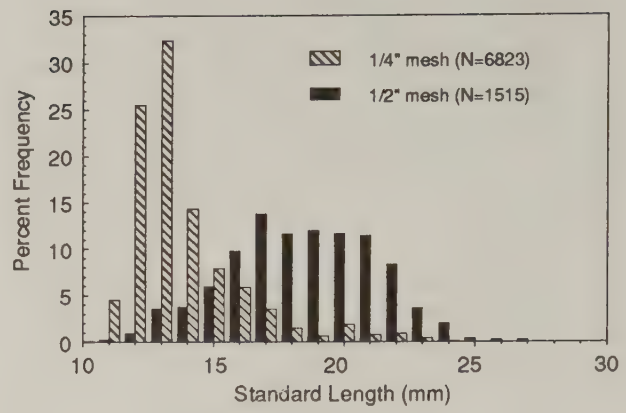

Figure 4. Size composition of pelagic juvenile shortbelly rockfish taken by two different mesh sizes during 1992 survey off Cypress Point and Davenport, California.

euphausiids and gelatinous zooplankton. Nonetheless, it was fortuitous that the net mesh data were collected this year due to the prevalence of small fish, which allowed a discrimination of the selectivity patterns between the two net sizes. (S. Ralston and D. Woodbury, [415] 435-3149)

GROUNDFISH PHYSIOLOGICAL ECOLOGY INVESTIGATION

Evidence Found for Vitellogenin Transport in the Serum of Yellowtail Rockfish, *Sebastes flavidus*, during Gestation

As part of a continuing study on the reproductive biology of yellowtail rockfish; serum nutrients, metabolites, enzymes, and ions have been measured monthly over seven annual cycles. A consistent pattern in these data has been an increase of serum calcium found in females relative to that found in males during the fall and winter months. Calcium has been shown to be incorporated into vitellogenin (the precursor of yolk, produced in the liver of mature females) in teleosts. Indeed, serum Ca^{++} has been employed as a surrogate measure for vitellogenin. When serum data are organized according to the stage of ovary maturation, it becomes clear that Ca^{++} remains significantly elevated during vitellogenesis and embryogenesis. It is not surprising that Ca^{++} should be elevated in female serum during yolk accumulation in oocytes (i.e., vitellogenesis) prior to fertilization. More interesting, however, are the elevated levels in female serum during embryogenesis. If elevated Ca^{++} reflects vitellogenin transport, this suggests that females are supplying embryos during gestation, contrary to the previously held contention that

yellowtail rockfish are lecithotrophic, or ovoviviparous.

To understand yolk protein dynamics better and provide validity to the contention that vitellogenin is transported to embryos during gestation, Fishery Biologists Bruce MacFarlane and Michael Bowers are analyzing the serum and yolk proteins of prefertilized and pregnant yellowtail rockfish, *Sebastes flavidus*. Serum and yolk extracts are being separated electrophoretically according to molecular weight on polyacrylamide gels containing sodium dodecyl sulphate (i.e., SDS-PAGE).

Early results support our hypothesis that serum of females in embryogenesis contains vitellogenin. Using Coomassie Blue as the staining agent, all protein bands present in vitellogenic females were present in gestating female serum. Moreover, male serum was deficient in one protein band relative to females. The estimated molecular weight of that protein band was 185 kilodaltons, approximating the molecular weight of known teleost vitellogenin. This protein band was found in females during all embryonic stages, which include early-celled, embryonic body, and eyed-larvae ovary maturation stages. Further studies assessing serum and yolk from more vitellogenic and embryogenic females, as well as immature and nonvitellogenic subjects, are planned. If collaboration can be arranged, the biologists would like to have the results of these studies confirmed by immunochemical techniques.

Should the preliminary evidence hold up to further evaluation, these results would be interesting. Research in Japan on *Sebastes taczanowskii*, a congener of yellowtail rockfish, demonstrated that vitellogenin is not transported in maternal serum to embryos during gestation. Yet, vitellogenin in serum of pregnant teleosts is not unknown. Very recent data suggest that female mosquitofish, *Gambusia affinis*, previously thought to be lecithotrophic, transport vitellogenin during embryogenesis. (R. B. MacFarlane, [415] 435-3149)

INFORMATION TECHNOLOGY SERVICES

LAN Manager Migration Progressing

The planned migration from the current 3COM 3+Share network to Microsoft's LAN Manager is progressing. Information Technology Services (ITS) has acquired the latest version of the new network operating system (version 2.1). The same version has been acquired and will also be run at the Honolulu Laboratory and the Long Beach Regional Office. Version 2.1 supports some of the "value added" features of 3COM's 3+Open, such as full support for locally attached Macintoshes using ethernet "nubus" adapter cards and partial Transmission Control Protocol/Internet Protocol (TCP/IP) support. The TCP/IP gives users the capability to interconnect with other computer equipment. Version 2.1 also offers a remote dial-in facility, which is expected to be an improvement on our present pcANYWHERE dial-in network access. LAN Manager's transport protocol is smaller than 3+Share's XNS protocol which will result in a reduced memory requirement when substituted for XNS on networked PCs.

LAN Manager will be run on a new AST file server which will replace our oldest 3COM file server. The new server, an AST Premium SE 4/33, is equipped with 16 megabytes of memory and a one-gigabyte hard disk. Access to the large disk is improved by a 32-bit Enhanced Industry Standard Architecture (EISA) bus and SCSI disk controller. The server's 32-bit network adapter will further improve data transfer rates.

In line with the LAN Manager migration, many personal computers (PCs) in the Administrative Group and in the Director's Office have recently been upgraded to 80386 central processing units (CPUs). These newer machines, with their better memory architectures and faster CPUs, are capable of running Microsoft Windows at acceptable speeds. They are installed with MS DOS 5.0. Users will find that MS Windows provides a perfectly matched interface to the new LAN Manager network operating system. Microsoft's (MS) DOS 5.0, with its very good memory management, and MS Windows 3.1, with its graphical user interface and memory-management enhancements, are excellent products and will improve on the performance and ease-of-use for network-connected PCs.

In order to further prepare for the migration, Frank Ralston recently attended a course on the administration of LAN Manager networks offered at Microsoft University in Foster City, California.

At the time of the cutover to LAN Manager, the 3+Mail email package that has become a mainstay to users at the La Jolla Lab, and generally to the National Marine Fisheries Service (NMFS) as well, will be replaced by the third-party email product cc:MAIL. cc:MAIL is a full-featured email package that has been recommended by the NMFS

National Data Management Committee (NDMC) as the NMFS email standard. The NMFS Headquarters offices in Silver Springs, Maryland, have already begun converting to this new email package. La Jolla and other sites in the Southwest will join them in the not-too-distant future. It is expected that cc:MAIL will improve communications to the NMFS sites at Pacific Fisheries and Environmental Group (PFEG) in Monterey and at the Southwest Fisheries Science Center (SWFSC) Laboratory at Tiburon, California. The link between these sites and La Jolla under cc:MAIL will be dynamic and will improve upon the current "store-and-forward" connection now being used between these sites.

General training and orientation for new users will be provided before the transition is implemented. (Frank Ralston, [619] 546-7062)

PUBLICATIONS

Published

Ballance, L. T. 1992. Habitat use patterns and ranges of the bottlenose dolphin in the Gulf of California, Mexico. Mar. Mammal Sci. 8(3):262-274.

The author studied behavior and range patterns of individual bottlenose dolphins during 1984 in the mid-eastern Gulf of California, Mexico. Dolphin sighting rates were significantly higher in areas close to estuary mouths, 0.306 sightings per hour compared with 0.155 sightings per hour in areas distant from estuary mouths. Dolphins used these estuarine areas to feed; 61 percent of all behavior observed near estuaries was feeding as compared with 23 percent elsewhere. Traveling comprised 61 percent of all behavior observed in areas distant from estuary mouths. Estuaries are sites of large concentrations of nutrients which support great numbers of filter-feeding zooplankton and fish. Bottlenose dolphins may specialize on estuarine prey, or they may feed in estuarine areas simply because of the abundance of potential prey that these systems support. In either case, data on relative numbers, distribution patterns, and behavior and diet indicate that this is a general trend in habitat use for many coastal populations of this species in the Pacific and Atlantic.

Ranges of a few individuals spanned a minimum of 65 km of coastline, and animals were not permanent residents of monitored bay. In contrast, dolphins off the coast of Sarasota, Florida, have been reported to be year-round residents with smaller ranges. This difference in degree of site fidelity may be related to habitat difference. The west coast of Florida is dotted with numerous large estuarine systems which may host permanent prey populations and support resident groups of dolphins. The Gulf of California coastline contains few estuaries; most are small and perhaps support prey resources which are ephemeral, requiring dolphins to range over large distances in search of food.

Banish, L. D., and W. G. Gilmartin. 1992. Pathological findings in the Hawaiian monk seal. J. Wild. Dis. 28(3):428-434.

Postmortem examinations were performed on 45 Hawaiian monk seals, *Monachus schauinslandi*, collected during field research on the beaches of the Northwestern Hawaiian Islands (USA) from 1981 to 1985. Both males and females of all age groups, perinatal through adult, were examined. Frequent findings included parasites, trauma, cardiovascular disease (congenital and acquired), and respiratory infections. Emaciation was a common condition. All animals except neonates were infected with parasites; infection was severe in several cases. Splenic hematopoiesis was a universal histopathologic finding. Some cases exhibited lesions consistent with renal, gastrointestinal, and toxic disorders; ectopic tissue calcification; gallstones; and ophthalmologic and dental problems.

Bowers, M. J. 1992. Annual reproductive cycle of oocytes and embryos of yellowtail rockfish, *Sebastes flavidus* (family Scorpaenidae). Fish. Bull., U.S. 90:231-242.

Female yellowtail rockfish, *Sebastes flavidus*, a viviparous species employing intraluminal gestation following fertilization of ovulated eggs, were caught from Cordell Bank (seamount 20 miles west of Pt. Reyes, central California) on a monthly basis from May 1985 through April 1986 to determine their annual reproductive cycle. Since histological methods provide precise and detailed information, this method was employed to (1) examine oocytes and embryos to describe developmental stages, and (2) provide temporal assessment of the annual reproductive cycle. The description and staging scheme developed provide a basis to compare reproductive developmental patterns between cycles and populations.

Oogonia (Stage I) and early perinucleolus (Stage II) oocytes were present in samples from the whole month. Progressive growth of oocytes from early-to-late perinucleolus (Stage III) was evident in spent and recovering ovaries, indicating the end of a reproductive year and the beginning of a new reproductive cycle. Initial yolk accumulation (Stage IV) occurred in July, and final yolk accumulation (Stage V) was predominant from September through January. In February, the majority of samples displayed fertilized ova in early-celled stages of embryonic development. Gestation continued for about 30 days with parturition occurring between January and March. Mature oocytes were also collected in March, suggesting the Cordell Bank yellowtail population has a prolonged reproductive season extending into April.

Brill, R. W., P. G. Bushnell, D. R. Jones, and M. Shimizu. 1992. Effects of acute temperature change, *in vivo* and *in vitro*, on the acid-base status of blood from yellowfin tuna, *Thunnus albacores*. Can. J. Zool. 10:164-662.

In most fishes, blood acid-base regulation following a temperature change involves active adjustments of gill ion-exchange rates which take hours or days to complete. Previous studies have shown that isolated blood from skipjack tuna, *Katsuwonus pelamis*, and albacore, *Thunnus alalunga*, had rates of pH change with temperature (in the open system) equivalent to those necessary to retain net protein charge *in vivo* ($\approx 0.016\ _{\Delta}pH \bullet °C^{-1}$). It was postulated that this is due to protons leaving the hemoglobin and combining with plasma bicarbonate (HCO_3^-), which is removed as gaseous CO_2, and that this ability evolved so that tunas need not adjust gill ion-exchange rates to regulate blood pH appropriately following ambient temperature changes. The scientists re-examined this phenomenon using blood and separated plasma from yellowfin tuna, *Thunnus albacares*. Unlike previous studies, their CO_2 levels (0.5 and 1.5 percent CO_2) span those seen in yellowfin tuna arterial and venous blood. Various bicarbonate concentrations (HCO_3^-) were obtained by collecting blood from fully rested as well as vigorously exercised fish. They use their *in vitro* data to calculate basi physiochemical parameters for yellowfin tuna blood: nonbicarbonate buffering (β), the apparent first dissociation constant of carbonic acid (pK_{app}), and CO_2 solubility (αCO_2). They also determined the effects of acute temperature change on arterial pH, (HCO_3^-), and partial pressures of O_2 and CO_2 *in vivo*. The pH shift of yellowfin tuna blood subjected to a closed-system temperature change did not differ from previous studies of other teleosts ($\approx$-$0.16\ _{\Delta}pH \bullet °C^{-1}$). The pH shift in blood subjected to open-system temperature change was P_{CO_2} dependent and lower than that in skipjack tuna or albacore blood *in vitro* but identical with that seen in yellowfin tuna blood *in vivo*. However, pH adjustments *in vivo* were caused by changes in both (HCO_3^-) and P_{CO_2}. The exact mechanisms responsible for these changes remain to be elucidated.

Chivers, S. J., and P. A. Akin. 1991. Sampling effects on the estimation of life history parameters for eastern tropical Pacific dolphins. Rep. Int. Whal. Commn 41:525-527.

Specifications for the collection of life history data from eastern tropical Pacific dolphins have recently changed. Specimens are now only collected if a total of more than six animals are killed. For a one-year trial period, a monetary reward system was offered for each specimen with life history data collected. The effects of these changes are examined to determine whether the resultant life history data are biased--a concern expressed at the 1989 International Whaling Commission's Scientific Committee meeting. The collected data are stratified by the new requirements, and the representation of females by reproductive condition and by the number of calves is examined for each strata. Few statistically significant differences between the strata in the representation of animals in the sample were found, and no systematic biases were detected in the representation of specimens in the collection. The monetary reward system resulted in a significant increase in the number of specimens collected.

Conlan, K. E., and J. R. Chess. 1992. Phylogeny and ecology of a kelp-boring amphipod, *Peramphithoe stypotrupetes*, new species (Corophioidea Ampithoidae). J. Crustacean Biol. 12(3):410-422.

A new species of ampithoid amphipod has been found which bores into and occupies the interior of abraded stipes of kelps on the Pacific coast of North America. Adult bisexual pairs cohabit the stipes with their offspring of several generations. The *Peramphithoe stypotrupetes* new species is diagnosed, illustrated, and its boring habits are described. The type for the genus, *Peramphithoe femorata* (Krøyer 1845), is redescribed, illustrated, and compared with the new species. *Peramphithoe stypotrupetes* can be distinguished from *P. femorata* and other eastern Pacific species of the genus by its shorter pair of first antennae and narrower pereiopod 3 and 4 bases. Relationships are compared cladistically and biogeographically and are presented in a key.

Everson, A. R., R. A. Skillman, and J. J. Polovina. 1992. Evaluation of rectangular and circular escape vents in the Northwestern Hawaiian Islands lobster fishery. N. Am. J. Fish. Manag. 12:161-171.

Research was conducted in Hawaii during 1984-1987 to investigate the possibility that escape vents fitted in traps used by the commercial lobster fishery in the Northwestern Hawaiian Islands would reduce the catch and mortality of sublegal spiny lobsters, *Panulirus marginatus*, (2-mm tail width) and slipper lobsters, *Scyllarides* spp., (8-mm tail width) without significantly reducing legal catch. A circular vent was more efficient than the traditional rectangular vent in maximizing escapement of sublegal lobsters and retention of legal ones for both species. Optimum results were attained with two vented panels, each containing four 67-mm-diameter circular vents. Traps equipped with the circular vents caught 83 percent fewer spiny lobsters and 93 percent fewer sublegal slipper lobsters than nonvented control traps, and they did not significantly reduce legal catch of either species. In contrast, traps with two 49-mm-high x 285-mm-wide rectangular vents reduced the catch of sublegal spiny and slipper lobsters by 70 and 93 percent, respectively, but also reduced legal slipper lobster retention by a significant 32 percent of the control catch. As a result of this research, all traps used in the lobster fishery in the Northwestern Hawaiian Islands after January 1, 1988, must be equipped with two panels with 67-mm circular vents. The 1988 catch of sublegal spiny lobsters declined by 38 percent at

Necker Island, Northwestern Hawaiian Islands, whereas the legal catch increased substantially.

Hill, S. P., and J. Barlow. 1992. Report of a marine mammal survey off the California coast aboard the research vessel *McArthur*. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-169, 103 p.

A 3-month ship survey of cetaceans off the coast of California was made to estimate the size of those populations that are being impacted by gillnet fisheries in this region.

Primary objectives of the cruise were to estimate the abundance and understand the distribution of dolphin and whale species that are common in California waters and that are killed in U.S. commercial gillnetting operations. Specific objectives were to (1) collect data for estimating the density, size, and species composition of dolphin and whale aggregations in order to make mean and minimum estimates of their population sizes; (2) collect physical, biological, and oceanographic data regarding the habitat of marine mammals to better understand why they are distributed as they are; (3) take individual identification photographs of blue, humpback, right, and sperm whales to estimate their population size using mark-recapture methods; and (4) take biopsy samples from whales and dolphins for future genetic analysis of population structure.

The survey took place aboard the research vessel *McArthur* November 5, 1991, and consisted of four legs.

Data in this report represent marine mammal encounter rates, group size, and species composition meeting the primary objectives of the study. Data on all marine mammal sightings have been summarized.

It was found that the rate of encountering marine mammal groups was higher during calm seas than during rough seas, and the rate during good visibility conditions was lower than the encounter rate during poor visibility conditions. Encounter rates among observers was variable.

Hobbs, R. C., L. W. Botsford, and R. Kope. 1990. Bioeconomic evaluation of the culture/stocking concept for California halibut. *In* Haugen, Charles W. (ed.), The California halibut, *Paralichthys californicus*, resource and fisheries, p. 417-449. Calif. Dep. Fish Game Fish Bull. 174.

The authors describe development of a model used to evaluate the bioeconomics of culture for stocking of the California halibut, *Paralichthys californicus*. Results from this model provide guidance for future research and preliminary estimates of feasibility. The model mimics growth of a cohort in culture from postlarvae to release, then in the ocean from release to mortality from natural causes or the fishery. Costs of culture and the benefits of cultured fish to the fishery are calculated. The latter are given in terms of number of released fish caught, biomass caught per release, cost per fish caught, and net benefit per released fish. The cost of post-larval fish is shown to be a substantial part of culture costs and should be reduced if possible. They demonstrate a graphical method for determining the release time that minimizes cost per recruit. For current parameter values, this value is about 300 days. Both culture costs and optimal release time are sensitive to costs of food and space. They graphically show the trade-off between high growth rate and high costs of culture feeds. The cost of producing a recruit depends on post-release survival rate but is not as sensitive as expected because of a compensatory shift in optimal release age. Costs per released fish caught could be near $5/fish if natural growth rates could be achieved in culture and the culture period could be extended to 300 days.

Hobson, E. S. 1991. Trophic relationships of fishes specialized to feed on zooplankters above coral reefs. Ecol. Fish. Coral Reefs 4:69-95.

Fishes specialized to feed on zooplankters are major components of coral reef communities. They are distinctive animals, with many features that relate to their way of feeding. Although most fishes are planktivorous as larvae and early juveniles, generally only species with appropriate adaptations remain obligate planktivores as adults. This chapter examines how these species have accommodated the special needs of planktivory while retaining close ties to reef structures, generally as places to shelter when at rest or threatened.

Hohn, A. A., R. B. Miller, K. M. Peltier, and S. J. Chivers. 1991. Composition of the incidental kill of small cetaceans in the U.S. purse-seine fishery for tuna in the eastern tropical Pacific during 1989. Rep. Int. Whal. Commn 41:493-496.

The composition of the 1989 incidental kill of small cetaceans during 123 fishing trips by the U.S. tuna purse-seine fleet is given by area, species, stock, sex, length; and, for females, reproductive condition. This year was the first of three consecutive years (1989-1991) in which 100 percent of the fishing trips will be observed. Mortality was reported for spotted dolphins from the northern offshore and southern stocks; spinner dolphins from the eastern stock and northern and southern whitebelly stocks; common, striped, bottlenose and rough-toothed dolphins; and for a short-finned pilot whale. The number of females from which reproductive samples were collected and for which species/stock was known increased from 767 in 1988 to 1,322 in 1989.

Holland, K. N., R. W. Brill, R. K. C. Chang, J. R. Sibert, and D. A. Fournier. 1992. Physiological and behavioral thermoregulation in bigeye tuna, *Thunnus obesus*. Nature 358:410-412.

Tuna are unique among teleost fishes in being thermoconserving. Vascular counter-current heat ex-

changers maintain body temperatures above ambient water temperature, thereby improving locomotor muscle efficiency, especially at burst speeds and when pursuing prey below the thermocline. Because tuna also occasionally swim rapidly in warm surface waters, it has been hypothesized that tuna thermoregulate to accommodate changing activity levels or ambient temperatures. But previous field experiments have been unable to demonstrate definitively short-latency, mammalian-type physiological thermoregulation. Here the authors show, using telemetered data, that free-ranging bigeye tuna, *Thunnus obesus*, can rapidly alter whole-body thermal conductivity by two orders of magnitude. The heat exchangers are disengaged to allow rapid warming as the tuna ascend from cold water into warmer surface waters and are reactivated to conserve heat when they return into the depths. Combining physiological and behavioral thermoregulation expands the foraging space of bigeye tuna into otherwise prohibitively cold, deep water.

Holland, R. C. 1992. A program for the Microsoft Windows environment to collect analog-to-digital and serial communication data on a personal computer-based system. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-170, 15 p.

PCPluss for Windows, a Visual Basic program, and the companion programs were developed to sample continuous and discrete data from a variety of environmental sensors during transits of a research vessel (R/V); it was specifically designed for the Pacific research cruises MOPS (Monitoring of Porpoise Stocks), PODS (Population of Delphinus Stocks), and CAMMS (California Marine Mammal Survey). It was designed to run on an inexpensive personal computer but also has potential for use in any R/V oceanographic program.

PCPluss was designed to sample, average, and store multiple streams of data from a variety of sources. It is presently being configured to directly use an analog-to-digital board and convert analog data from a Turner Designs fluorometer (flow-thru Model 10) to a 12-bit digital form, collect temperature and salinity data from a Sea-bird thermosalinograph through a communication port, and to collect satellite navigation latitude and longitude locations through a second communication port. It is also possible to reconfigure the system to sample from other types of sensors.

Kope, R. G. 1992. Optimal harvest rates for mixed stocks of natural and hatchery fish. Can. J. Fish. Aquat. Sci. 49(5):931-938.

Optimal harvest rates were computed using dynamic programming for mixed-stock fisheries exploiting two stocks of either natural or hatchery origin. Natural stocks were described by a Ricker spawner-recruit relationship and hatchery stocks were described by a rectilinear spawner-recruit relationship. Harvest rates were optimized for both risk-neutral and risk-averse utility functions. For two natural stocks with low productivities, optimal harvest rates generally appeared to favor the stronger stock for a risk-neutral utility function and the weaker stock for a risk-averse utility function. For both utility functions, optimal harvest policy became less sensitive to relative stock strength as the productivity of the stocks increased. When at least one of the stocks was of hatchery origin, optimal harvest policy favored the weaker stock using either utility function.

Laidig, T. E., and D. E. Pearson. 1992. Documentation of three computer programs used to assess daily age from the hard structures of animals. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-168, 44 p.

Documentation for the three main daily ageing programs used at the Tiburon Laboratory is discussed. AGE1.EXE is a data collection program, designed to gather data from multiple otoliths and multiple transects from the same otolith. EDIT.EXE is a data edit program for the files created by AGE1.EXE. AGE2.EXE interprets the files from AGE1.EXE and produces daily ages and birthdates for the fish being analyzed. A step-by-step procedure is laid out for each program, and a description of how each program functions is included.

Muench, R. D., B. A. Huber, J. T. Gunn, D. M. Husby, and D. G. Mountain. 1992. The Weddell-Scotia marginal ice zone: physical oceanographic conditions, geographical and seasonal variability. J. Mar. Systems 2:169-182.

Physical oceanographic conditions were measured in the Weddell and Scotia Sea marginal ice zones (MIZs) during 1983, 1986, and 1988. The field work encompassed spring, autumn, and mid-winter periods and included retreating, advancing, and steady-state ice edges. Observed upper ocean structures, which typify MIZs and reflect input of low salinity water from melting ice, included low salinity upper layers, lenses, and fronts. An upper mixed layer was always present and was generally more fully developed in autumn and winter than at other times of year. Conditions in the deeper waters reflected regional oceanographic processes, and significant differences were present between the Weddell and Scotia seas. Weddell Sea Water is a major source of water for the southern Scotia Sea; however, the upper Scotia Sea was dominated by warmer, less saline waters from Drake Passage. The colder, denser Weddell water appeared to have mixed isopycnally with deeper water in the Scotia Sea, present there at depths exceeding 500 m.

The Scotia Sea was dominated by strong gradients and energetic mesoscale features, with currents exceeding 50 cm/s. The northwestern Weddell Sea had, in contrast, current speeds well below about 5 cm/s and small-to-negligible lateral water property gradients. Our observations suggest that the Weddell western boundary current was weaker than has been esti-

mated in the past. In addition, we found scant evidence of deep winter convection in the Scotia Sea, a process which has been hypothesized in the past to contribute to deep water formation. No evidence was found during the 1988 winter in the Scotia Sea of the modified water known as Weddell-Scotia Confluence water.

Niethammer, K. R., G. H.Balazs, G. L. Nakai, and D. K. McDermond. 1992. Great frigatebird, *Fregata minor*, predation: not a factor in hatching green turtle, *Chelonia mydas*, survival at French Frigate Shoals, Hawaii. Colonial Waterbirds 15(1):128-131.

Frigatebirds are known predators of sea turtle hatchlings at several locations worldwide. At certain localities this predation might excerbate the already endangered status of these marine reptiles. French Frigate Shoals, Hawaii, is where over 90 percent of all Hawaiian green turtle, *Chelonia mydas*, breeding occurs and is the site of a large great frigatebird, *Fregata minor*, colony. Frigatebird predation was not a factor in hatchling survival at this location. The researchers found no evidence of green turtle hatchlings in the stomach contents of 200 great frigatebirds sampled during peak periods of hatchling emergence in 1988 and 1989.

Salvadó, A. M., P. Kleiber, and A. E. Dizon. 1992. Optimal course by dolphins for detection avoidance. Fish. Bull., U.S. 90:417-420.

Schneider, D. C., D. C. Duffy, A. D. MacCall, and D. W. Anderson. 1992. Seabird-fisheries interactions: Evaluation with dimensionless ratios. *In* McCullough, Dale R., and Reginald H. Barrett (eds.), Wildlife 2001: Populations, p. 602-615. Elsevier Applied Science, London and New York.

Marine bird populations interact with fisheries in a variety of ways, with diverse outcomes. Evaluation of these outcomes requires a means of comparison across cases, and a means of identifying the relative importance of concomitant processes at relevant space and time scales. The authors describe a general quantitative framework that permits comparison of quantitative findings among studies of seabird-fisheries interactions. They then review the results of seabird-fisheries studies within this framework. The authors discuss the use of ad hoc ratios and dimensional analysis to make decisions about competing processes at relevant space and time scales.

Squires, D. 1992. Productivity measurement in common property resource industries: and application to the Pacific coast trawl fishery. RAND Journal of Economics 23(2):221-236.

This article measures total factor productivity in industries that exploit resources held in common. Particular attention is paid to the valuation and specification of in situ common-property resources in a neoclassical production technology, catchability of the resource, and variations in economic capacity utilization. An empirical analysis of the open-access Pacific coast trawl fishing industry demonstrates that disentangling the productivity residual from changes in resource abundance, its catchability, and variations in capacity utilization hones the productivity residual to finer precision, lowering mean productivity growth by about half. Removing biological noise from variable resources is also important. The results are related to a program limiting the number of vessels and can contribute to sustainable resource management whenever resources are held in common.

Stewart-Oaten, A., J. R. Bence, and C. Osenberg. 1992. Assessing effects of unreplicated perturbations: No simple solutions. Ecology 73(4):1396-1404.

The authors address the task of determining the effects, on mean population density or other parameters, of an unreplicated perturbation, such as arises in environmental assessments and some ecosystem-level experiments. Their context is the Before-After-Control-Impact-Pairs design (BACIP): on several dates before and after the perturbation, samples are collected simultaneously at both the impact site and at a nearby "control."

One approach is to test whether the mean of the impact-control difference has changed from before to after the perturbation. If a conventional test is used, checks of its assumptions are an important and messy part of the analysis, since BACIP data do not necessarily satisfy them. It has been suggested that these checks are not needed for randomization tests because they are insensitive to some of these assumptions and can be adjusted to allow for others. A major aim of this paper is to refute this suggestion: there is no panacea for the difficult and messy technical problems in the analysis of data from assessments or unreplicated experiments.

The authors compare the randomization *t* test with the standard *t* test and the modified (Welch-Satterthwaite-Aspin) *t* test, which allows for unequal variances. They conclude that the randomization *t* test is less likely to yield valid inferences than is the Welch *t* test because it requires identical distributions for small sample sizes and either equal variances or equal sample sizes for larger ones. The formal requirement of normality is not crucial to the Welch *t* test.

Both parametric and randomization tests require that time and location effects be additive and that impact-control differences on different dates be independent. These assumptions should be tested; if they are seriously wrong, alternative analyses are needed. This will often require a long time series of data.

Finally, for assessing the importance of a perturbation, the *P* value of a hypothesis test is rarely as useful as an estimate of the size of the effect. Especially if effect size varies with time and conditions, flexible estima-

tion methods with approximate answers are preferable to formally exact *P* values.

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